

Some of the biological features of the Brond-snout (*Chondrostoma regium*, Heckel, 1843) living in Lake Ladik (Samsun, Turkey)

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Summary: This study investigates the biological features of 164 brond-snout *Chondrostoma regium* (Heckel, 1843) samples caught in Lake Ladik between January and March 2010 such as age and sex composition, length and weight distribution, length, age and weight relations and condition factors. The age was determined from the scales and the ages of the fishes were found to change between 2 and 5 years. The range of the total lengths and the weight of the samples were found to be 16.5-25.4 cm and 40.04-192.42 g respectively. The sex ratio (F/M) was found to be 1/0.29. The parameters of von Bertalanffy growth equations were $L_{\infty} = 28.15$ cm, $W_{\infty} = 254.16$ g, $k = 0.30$ year⁻¹ and $t_0 = -1.23$ year and the growth performance index value (ϕ') was found to be 2.38. The length-weight relation was found to be $W = 0.0029 TL^{3.41}$. There were strong relations among different lengths ($p < 0.001$, $r^2 > 0.98$). Fulton's condition factor was found to be 1.01 ± 0.09 .

Key words: *Chondrostoma regium*, Condition factor, Growth, Lake Ladik

Ladik Gölü (Samsun, Türkiye)'nde yaşayan Kababurun balığı (*Chondrostoma regium*, Heckel, 1843)'un bazı biyolojik özellikleri

Özet: Ladik Gölü'nden Ocak 2010-Mart 2010 tarihleri arasında yakalanan 164 adet kababurun balığı, *Chondrostoma regium* (Heckel, 1843) bireyinin yaş ve eşey kompozisyonu, boy ve ağırlık dağılımları, yaş, boy, ağırlık ilişkileri ve kondisyon faktörü gibi bazı biyolojik özellikleri incelendi. Yaş tayini pullardan yapıldı ve balıkların yaşlarının 2 ile 5 arasında değiştiği belirlendi. Örneklerin total boy ve ağırlıkları sırasıyla 16,5-25,4 cm ve 40,04-192,42 g arasındaydı. Eşey oranı (D/E) 1/0,29 olarak tespit edildi. Tüm örnekler için von Bertalanffy büyüme denklemi parametreleri $L_{\infty} = 28,15$ cm, $W_{\infty} = 254,16$ g, $k = 0,30$ yıl⁻¹ ve $t_0 = -1,23$ yıl ve büyüme performans indeksi değeri (ϕ') 2,38 olarak hesaplandı. Boy-ağırlık ilişkisi $W = 0,0029 TB^{3,41}$ şeklinde elde edildi. Ölçülen farklı boy uzunlukları arasında kuvvetli ilişkiler belirlendi ($p < 0,001$, $r^2 > 0,98$). Fulton'un kondisyon faktörü değeri tüm bireyler için $1,01 \pm 0,09$ olarak tespit edildi.

Anahtar sözcükler: Büyüme, *Chondrostoma regium*, kondisyon, Ladik Gölü.

Introduction

Lake Ladik is one of the important wetlands of Samsun province after Kızılırmak and Yeşilirmak deltas. As well as housing so many types of the animals and organisms the lake is a very interesting natural site area with its floating isles (2). It is located between 35°40'-36°05' east longitudes and 40°50'-41°00' north latitudes. The lake was 10 km away from the Ladik town. There is Akdağ Mountain at its South. The lake is fed by various streams but loses waters by Tersakan Stream connected to Yeşilirmak River. The lake is 5 km long, 2 km wide and 2.5-6 m deep located at an altitude of 867 m (1). The surface water temperature varies between 3.8-25.2 °C (15) and it is classified to a eutrophic lake (11). Ten fish species such as *Abramis brama*, *Barbatula kosswigi*, *Blicca bjoerkna*, *Capoeta tinca*, *Chondrostoma regium*, *Esox lucius*, *Perca fluviatilis*, *Scardinius erythrophthalmus*,

Squalius cephalus and *Carassius gibelio* are present in this lake (21,25).

There are very limited studies related to the biological features of fish species of Lake Ladik. Polat et al. (15) investigated the age, growth, feeding and breeding features of *Abramis brama*, *Esox lucius* and *Perca fluviatilis*; Yılmaz et al. (25) dealt with same biological features of *Blicca bjoerkna* and its length-weight relations and condition factors and Yazıcı (24) examined the age and growth features *Scardinius erythrophthalmus*.

This study is related to the investigation of the biological features of brond-snout *Chondrostoma regium* living in Lake Ladik such as age and gender composition, length and weight distribution and age, weight and length relations and the condition factors. The data obtained were compared with the result reported for the same species in different habitats.

Material and Method

Sampling was carried out monthly between November 2009 and October 2010 at different regions of Lake Ladik. The nets with mesh size of 20, 25, 30, 35, 40, 45, 50, 60, 70, and 80 mm were used to capture of fish specimens. Totally, 182 brood-snout samples were obtained during the sampling period. Because no fish were caught in some months and few specimens were captured in other some months, a total of 164 *Chondrostoma regium* individuals collected between January and March 2010 were used to this study. The total, fork and standard lengths of the fish were measured with an accuracy of 0.1 cm and their weights were determined with an accuracy of 0.01 g. Sex was determined by the macroscopic examination of their gonads. The chi-square (χ^2) test was employed to determine whether the sex ratio was different than the expected value of 1/1 (26). The ages of the sample were determined by the use of the scales taken from the antero-dorsal region of the fish. The scales were prepared according to method of Chugunova (5).

The age-length and the age-weight relations of the samples were determined by the use of von Bertalanffy growth equations $L_t = L_\infty [1 - e^{-k(t-t_0)}]$ and $W_t = W_\infty [1 - e^{-k(t-t_0)}]^b$ respectively (17). Here L_t is the fork length of the fish at the age of t (cm), L_∞ = theoretically accessible maximum fork length (cm), k = growth coefficient, t_0 = the age where the fish length is theoretically zero (years), W_t = weight of the fish at the age of t (g), W_∞ = theoretically accessible maximum weight (g) and b = exponential value in weight-length relation. The growth of the fish was compared by the use of growth performance index, $\Phi' = \text{Log } k + 2 \text{ Log } L_\infty$ (12). The parameters of L_∞ , k and t_0 in the growth equations and Φ' were computed with use of FISAT II program (8) and W_∞ and b values were determined from the length-weight relation. The length-weight relation was given as $W = aL^b$ where W = the weight of the fish (g), L = total length (cm) and a and b are constants (16). The values of a and b were determined from the linear regression formula of $\log W = \log a + b \log L$ obtained from this equation. The fact that whether the parameter of b are different from the isometric growth coefficients ($b=3$) was checked by t-test (26). The total length-fork length, fork length-standard length and standard length-total length relations for all the samples were determined with the linear relation formula ($y = a + bx$). Fulton's condition factor was determined separately for all the length groups for both sex with the use of $CF = W \times 100 / L^3$ equation (16). Here CF represents Fulton's condition factor and L signifies the total length (cm). The difference between the CF values was determined with t-test (26).

Table 1. The age and sex composition of *Chondrostoma regium* samples caught in Lake Ladik (N, number of samples).

Tablo 1. Ladik Gölü'nden yakalanan *Chondrostoma regium* örneklerinde yaş ve eşey kompozisyonu (N, örnek sayısı).

Age groups	Female		Male		Female + Male	
	N	% N	N	% N	N	% N
II	25	15.24	21	12.80	46	28.04
III	54	32.93	14	8.54	68	41.47
IV	29	17.68	1	0.61	30	18.29
V	19	11.59	1	0.61	20	12.20
Total	127	77.44	37	22.56	164	100.00

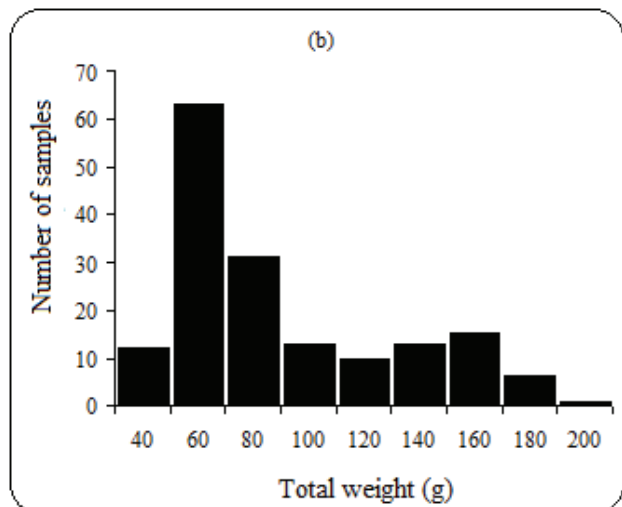
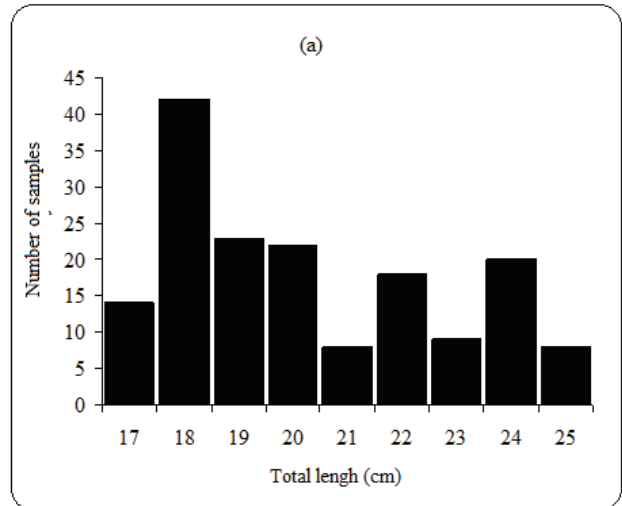


Figure 1. The distributions of length (a) and weight (b) of *Chondrostoma regium* samples caught in Lake Ladik.

Şekil 1. Ladik Gölü'nden elde edilen *Chondrostoma regium* örneklerinde boy (a) ve ağırlık (b) dağılımı.

Results

From the total of 164 specimens, 127 (77.44%) were females and 37 (22.56%) were males (Table 1). The F/M ratio was found to be 1/0.29. This ratio was markedly different than the expected ratio of 1/1 ($\chi^2 = 26.706 > \chi^2_{0.05, 1} = 3.84$, $P < 0.001$). The age was found to be between 2-5 years. Among the total number of females the III age group and among the total number of males the II age group were found to be dominant.

The total lengths of the samples varied between 16.5 and 25.4 cm. The highest number of samples was found to be in 18 cm mean length group (Figure 1a). The weights were observed to be in the range of 40.04 to 194.42 g. The samples between 50-70 g ranges were found to be dominant in the total number of fish caught (Figure 1b).

The total lengths and weights according to age groups and sexes are given in Table 2. The difference between mean total lengths and weights of the males and the females in same age group was observed to be not significant (t-test, $p > 0.05$).

The von Bertalanffy growth equations expressing the age-length and age-weight relations and their graphics are shown in Figure 2 and Figure 3. The growth performance index (Φ') was found to be 2.38.

There were strong relations between the lengths and weights of the *Chondrostoma regium* specimens living in Lake Ladik ($p < 0.001$, $r^2 > 0.92$, Table 3). According to parameter b of length-weight relation, the positive allometric growth was observed for females and all samples ($b > 3$, t-test, $p < 0.05$) while isometric growth was determined for males ($b = 3$, t-test, $p > 0.05$).

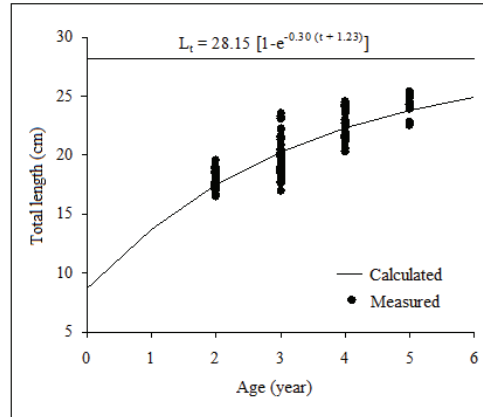


Figure 2. The growth curve in length of *Chondrostoma regium* samples caught in Lake Ladik.

Şekil 2. Ladik Gölü'ndeki *Chondrostoma regium* örneklerinde boyca büyüme denklemi ve eğrisi.

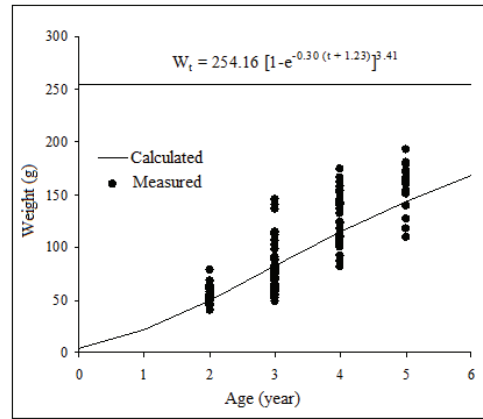


Figure 3. The growth curve in weight of *Chondrostoma regium* samples caught in Lake Ladik.

Şekil 3. Ladik Gölü'ndeki *Chondrostoma regium* örneklerinde ağırlıkça büyüme denklemi ve eğrisi.

Table 2. The mean total length (cm) and weights (g) values of *Chondrostoma regium* samples caught in Lake Ladik according to ages and sexes (TL: total length, W: weight and SD: standard deviation).

Tablo 2. Ladik Gölü'nden yakalanan *Chondrostoma regium* bireylerinin yaş ve eşeylere göre ortalama total boy (cm) ve ağırlık (g) değerleri (TL: total boy, W: ağırlık, SD: standart sapma).

Age groups	Female		Male		Female + Male	
	TL \pm SD	W \pm SD	TL \pm SD	W \pm SD	TL \pm SD	W \pm SD
II	17.70 \pm 0.59	54.54 \pm 6.89	18.00 \pm 0.82	53.80 \pm 7.33	17.84 \pm 0.71	54.20 \pm 7.03
III	19.59 \pm 1.43	77.57 \pm 20.63	19.14 \pm 1.58	68.46 \pm 18.75	19.50 \pm 1.46	75.70 \pm 20.46
IV	22.60 \pm 1.22	127.61 \pm 25.15	21.50	103.28	22.56 \pm 1.21	126.80 \pm 25.11
V	24.35 \pm 0.81	158.71 \pm 19.57	22.80	117.97	24.27 \pm 0.86	156.67 \pm 21.12

Table 3. The parameters of length-weight relation of *Chondrostoma regium* living in Lake Ladik (L_{min} , minimum total length, L_{max} , maximum total length, W_{min} , minimum weight, W_{max} , maximum weight, a and b, constants, r^2 , coefficient of determination, +A, positive allometric growth, I, isometric growth).

Tablo 3. Ladik Gölü'ndeki *Chondrostoma regium* bireylerinde boy-ağırlık ilişkisi parametreleri (L_{min} , minimum total boy, L_{max} , maksimum total boy, W_{min} , minimum ağırlık, W_{max} , maksimum ağırlık, a ve b, ilişki sabitleri, r^2 , ilişki katsayısı, +A, pozitif allometrik büyüme, I, izometrik büyüme).

Sex	L_{min} - L_{max}	W_{min} - W_{max}	a	b	95 % Confidence Interval of b	r^2	Growth	Tipi
Female	16.7-25.4	45.27-192.42	0.0035	3.36	3.26-3.46	0.97	+A	
Male	16.5-22.8	40.04-117.97	0.0056	3.17	2.90-3.44	0.93	I	
Female + Male	16.5-25.4	40.04-192.42	0.0029	3.41	3.32-3.51	0.97	+A	

The relations between the total, fork and standard lengths for all the samples have been given in Table 4. All relations were highly significant ($p < 0.001$, $r^2 > 0.98$).

The values of Fulton's condition factor have shown an increase with the age groups. For the same age groups the CF values were found to change significantly between the females and the males (Table 5). The CF values for the females were found to higher than the males. The general difference between the CF values of the female and males were found to significant in the same age group (t-test, $p < 0.05$).

According to the Table 5 the CF values have shown a change of 0.96-1.11 with the total length groups. The CF value started to increase from the mean length group of 21 cm (Figure 4).

Table 4. Length-length relations of *Chondrostoma regium* samples. Table 4. *Chondrostoma regium* örneklerinde boy-boy ilişkileri.

Relation	Equation	r^2
Total length-Fork length	FL = 0.941 TL - 0.099	0.99
Fork length-standard length	SL = 0.939 FL - 0.532	0.99
Standard length-total length	TL = 1.117 SL + 0.964	0.99

Table 5. The condition factor (CF) values of *Chondrostoma regium* samples living in Lake Ladik according to sex and age groups.

Tablo 5. Ladik Gölü'ndeki *Chondrostoma regium* bireylerinin yaş ve eşeylere göre kondisyon faktörü değerleri (CF: kondisyon faktörü, SD: standart sapma).

Age groups	Female CF±SD	Male CF±SD	Female +Male CF±SD
II	0.98±0.08	0.92±0.04	0.95±0.07
III	1.01±0.07	0.96±0.08	1.00±0.07
IV	1.09±0.08	1.04	1.08±0.08
V	1.10±0.07	1.00	1.09±0.07
Mean	1.04±0.08	0.94±0.06	1.01±0.09

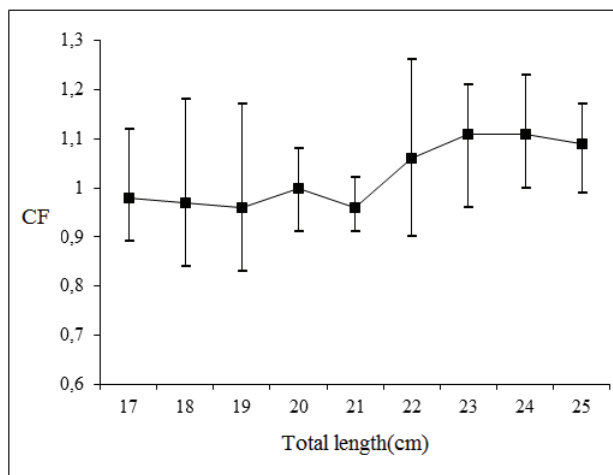


Figure 4. The change of the mean condition factors of the *Chondrostoma regium* samples living in Lake Ladik according to length groups.

Şekil 4. Ladik Gölü'ndeki *Chondrostoma regium* bireylerinin boy gruplarına göre ortalama kondisyon faktörü değişimi.

Discussion and Conclusion

This is the first study where the biological features of brood-snout *Chondrostoma regium* living in Lake Ladik have been elucidated. The study showed that the age, length and weight distribution were almost similar to results of previous studies but there was a marked difference in the sex ratio. The investigations on this species in different habitats showed that the number of females was generally higher than the number of males (Table 6). The variation of the weight and length compositions was attributed to the sampling time and method, sample size, the type of length measured and the ecological features of the habitats studied.

There were no statistically significant differences between lengths and weights of the male and female individuals of the population of *Chondrostoma regium* living in Lake Ladik. The results were similar with the data reported by Ünlü et al. (22), Oymak (13), Kara and Solak (10). The mean lengths and the weights according to age groups showed differences in various studies. These differences are reflected in the parameters of von Bertalanffy growth equations (Table 7). Generally the k values were high and L_{∞} and W_{∞} values were low. This situation applies to short-lived fish (16, 17). The maximum age results reported in others studies indicate that the *Chondrostoma regium* is a fish with a short life span (Table 6). The fact that the growth performance indices are very close to each other means that the growth of the species in different habitats are very close to each other.

The parameter a in the length-weight equation indicates the mean condition of the fish and the parameter b shows the shape of fish according to current conditions (3). The b values for different species were reported to change between 2 and 4 (4). In this study the b values were found to be within the expected limits for the male and female *Chondrostoma regium* (Table 3). The growth of the *Chondrostoma regium* females living in Lake Ladik was found to be allometric. The fact that the males were found to show isometric growth is thought to be due to lack of samples and the narrow range of lengths involved. The length-weight relation parameters of reported for the different populations of *Chondrostoma regium* at different localities are presented in Table 8. The results reported here were found to be in good compliance with the studies of Şevik (19), Oymak (13), Kara and Solak (10), Özcan (14), Suiçmez et al. (18). However the results reported here are somewhat different than the result of Kalkan and Erdemli (9) and Ergüden et al. (6). This can be attributed to differences in ecological characteristics of the study areas. It was reported that the length-weight relation parameters would change according to seasons, stomach contents, gonad development, sex, and length and weight distribution (20, 23). Length-length relations are very important for the comparison of growth studies (7). Different investigations on growth of *Chondrostoma regium* will be compared with length-length relations of this species.

Table 6. Sex ratio, age (year), length (cm) and weight (g) distributions of *Chondrostoma regium* living in different habitats (* fork length, F: Female, M: Male).Tablo 6. Farklı habitatlarda yaşayan *Chondrostoma regium* bireylerinde eşey oranı, yaş (yıl), boy (cm) ve ağırlık (g) dağılımları (*çatal boy, F: dişi, M: erkek).

Researcher(s)	Habitat	F/M Ratio	Age	Length	weight
Ünlü et al. (22)	Savur Stream	1/0.53	1-6	2.8-29.0*	11-296
Şevik (19)	River Euphrates	1/1.06	1-6	11.5-29.2*	17-283
Oymak (13)	Atatürk Dam Lake	1/0.71	1-8	13.0-30.5*	23-385
Kalkan and Erdemli (9)	Karakaya Dam Lake	1/1.23	2-5	20.4-31.8*	109-314
Kara and Solak (10)	Sır Dam Lake	1/0.82	1-5	15.5-26.0*	42-243
Ergüden et al. (6)	Seyhan Dam Lake	1/0.83	1-4	14.3-24.5	33-128
Suiçmez et al. (18)	Almus Dam Lake	1/0.66	1-6	13.7-28.1	19-240
This study	Lake Ladik	1/0.29	2-5	16.5-25.4	40-192

Table 7. The von Bertalanffy growth equation parameters and the growth performance indices for *Chondrostoma regium* reported in different studies (* fork length was calculated from **length-weight relationship).Tablo 7. Farklı çalışmalarda *Chondrostoma regium* için bildirilen von Bertalanffy büyüme denklemi parametreleri ve büyüme performans indeks değerleri (* çatal boy, ** boy-ağırlık ilişkisinden hesaplanmıştır).

Researcher(s)	Habitat	L_{∞} (cm)	W_{∞} (g)	k (year ⁻¹)	t_0 (year)	ϕ'
Ünlü et al. (22)	Savur Stream	26.74*	-	0.51	-3.21	2.56
Oymak (13)	Atatürk Dam Lake	34.81*	517.59	0.17	-2.96	2.31
Kara and Solak (10)	Sır Dam Lake	31.98*	372.47	0.18	-3.36	2.26
Ergüden et al. (6)	Seyhan Dam Lake	28.06	217.50	0.25	-1.86	2.29
Suiçmez et al. (18)	Almus Dam Lake	32.89	371.59**	0.24	-1.58	2.41
This study	Lake Ladik	28.15	254.16	0.30	-1.23	2.38

Table 8. The comparison of the length-weight relation parameters of *Chondrostoma regium* reported by different studies.Tablo 8. Farklı çalışmalardan bildirilen *Chondrostoma regium*'ün boy-ağırlık ilişkisi parametreleri.

Researcher (s)	Habitat	a	b	r ²
Şevik (19)	River Euphrates	0.000008	3.04	-
Oymak (13)	Atatürk Dam Lake	0.000003	3.24	0.93
Kalkan and Erdemli(9)	Karakaya Dam Lake	0.1953	2.12	-
Kara and Solak (10)	Sır Dam Lake	0.0092	3.07	0.83
Özcan (14)	Hatay	0.0010	3.28	0.71
Ergüden et al. (6)	Seyhan Dam Lake	0.0327	2.64	0.93
Suiçmez et al. (18)	Almus Dam Lake	0.0039	3.28	0.98
This study	Lake Ladik	0.0029	3.41	0.97

Table 9. The mean condition factors of *Chondrostoma regium* population living in different habitats according to age groups (* fork length).Tablo 9. Farklı habitatlardaki *Chondrostoma regium* populasyonlarında yaş gruplarına göre ortalama kondisyon faktörü (* çatal boy).

Researcher(s)	Habitat	Age Groups						
		I	II	III	IV	V	VI	VII
Şevik* (19)	River Euphrates	1.11	0.99	1.06	1.07	1.12	1.14	-
Oymak* (13)	Atatürk Dam Lake	0.87	1.06	1.07	1.11	1.16	1.21	1.35
Kalkan and Erdemli* (9)	Karakaya Dam Lake	-	1.25	0.99	1.01	1.08	-	-
Kara and Solak*(10)	Sır Dam Lake	1.12	1.13	1.20	1.25	1.29	-	-
This study	Lake Ladik	-	0.95	1.00	1.08	1.09	-	-

In this study the conditions of the females were found to be higher than the males ($p < 0.05$). This is in compliance of the data of Oymak (13), and Kara and Solak (10) who reported that although there were no statistically significant differences the conditions of the females were better than the males. On the other hand Kalkan and Erdemli (9) and Suiçmez et al. (18) found that the males have better conditions. Finally Ergüden et al. claimed that the conditions of the males and the females were almost the same (6). The conditions factor was reported to increase with the age (Tablo 9). This complies well with the data obtained in our study. It was also emphasized that the hunting of this species should be directed towards the older and bigger fish in order to allow the condition factor of the species to increase. Also the condition factor calculated for the general population of *Chondrostoma regium* in Lake Ladik for different age groups was found to be lower than expected. This situation was attributed to the type of length measured.

In conclusion this is the first study on some biological features such as growth, sex ratio, age distribution of *Chondrostoma regium* population living in Lake Ladik. We can easily claim that the data obtained in this study shows a good parallelism with other habitats as regards to their growth and feeding. In addition, its stock structure, reproductive and nutritional properties in this lake should be investigated and then the necessary protection measures should be determined.

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